NOTES ON THE ANATOMY AND PHYSIOLOGY OF THE UNIONIDAE.*

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The Unionidae are not only the most conspicuous part of our molluscan fauna, but also the most interesting. Some of their anatomical and physiological features have come to our knowledge only recently, and in few groups of animals, have the last ten to fifteen years brought such radical changes of classification. Up to 1900, the genera were generally based upon the shells: those with complete (regarding the family) hinges were called *Unio*, those with more or less defective hinges were *Alasmidonta*, or *Margaritana*, and those without hinge teeth were *Anodonta*. Conchologists generally know that the groups and genera are now established principally on the soft parts, mainly the branchiae, not exactly coincident with the formation of the shells. The branchiae, or gills, of this group of mollusca, have three very different functions: respiration, nutrition (as food gatherers), and as brood chambers for the ova and embryos.

The general morphology and anatomy of the fresh-water mussels is well known, but the special features are frequently not mentioned, or very fragmentarily, in text books on zoology, and not even in recent special works on mollusca. Our lowest form, at least in one group, and in one direction, the small *Anodonta imbecillis* Say, is hermaphrodite, that is: part of the gonad is ovary, another is testis. Other *Anodontae* have not been sufficiently examined in this respect. The balance of our *Unionidae* are typically unisexual, yet among *Quadrula*, and even *Lampsilis* (parva, Barnes), bisexual individuals are occasionally found.

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It is known that the ova, from the ovary, pass through an oviduct on each side into the branchiae, where they develop into embryos, the so-called glochidia. The glochidium, of about the size of the ovum, has a two-valved shell, very different from the postembryonal shell, and also of markedly different formation in the several groups, and a very primitive formation of the soft parts, without alimentary canal, ganglia, branchiae, etc.

The formation of the female reproductive branchiae is varied and furnishes principal characters for classification. In some of the groups, the *Unioninae* (*Unio, Pleurobema, Quadrula*), also the *Anodontinae* (*Anodonta, Alasmidonta, Gymphynota*, etc.), the branchiae which receive the ova, in their whole extent, show only slight and macroscopically barely noticeable differences from the male branchiae, and the non-receptive of the female. In a still higher group, only a part of each of the outer branchiae is noticeably differentiated, the so-called marsupium, consisting of ovisacs, their number being very different in the several groups, and approximately constant in adult individuals of each species. Also their configuration shows differences, when barren, and much more so when charged. This is the group, or subfamily *Lampsilinae*, and, with some differences, *Proptera*. In *Ptychobranchus* (e. g. *phaseolus* Hildreth), the outer branchiae are differentiated in their whole extent, and of a formation markedly different from that of the others, when gravid.

In the lower forms, there are no or slightly marked differences of the shells between males and females. With the appearance of the marsupium which, when filled and distended, projects more or less over the general contour and the lower edge of the branchiae, there comes a corresponding distension of the shell in the female, not or slightly marked in some forms, strongly so in others, e. g., most of the species of *Lampsilis*. It reaches its highest grade in *Truncilla*, where that part of the female shell is not only greatly distended but also of a formation and sculpture different from the rest of the mussel.

These differences, gradations, of both soft parts and shell, are naturally not in a straight line, the same as in other groups of animals, but with ramifications and gaps, which latter would probably be bridged over by extinct forms, and possibly by such as are living in other zoo-geographical provinces.

In connection with the different formation of the gravid branchiae, there are also different ways of discharging the embryos. In the *Unioninae* the young are expelled upward from the brood chambers into the suprabranchial canal and from there out into the water through the anal siphonal mantle opening. But in the *Lampsilinae*, each ovisac opens, at its inferior end, and the contents, coherent as a cake ("placenta"), makes its exit through that rent, and out either through the branchial siphonal

opening, or simply through the great slit of the mantle on the ventral side.

Of the first stages of post-embryonal development, we still know little. It has been observed, in Europe, many years ago, that the glochidia of *Anodonta* attached themselves on fins, gills, etc., of fishes, are there inclosed in a cyst-like cavity by local hypertrophy of the host's epidermis or epithelium, and live as parasites for weeks or months. In our country, some observations of this kind have been made, but I have not seen a report on them. There is an excellent opportunity here for observations and experiments.

At a later stage, small mussels—some less than two millimeters long—are found with post-embryonal shells, still bearing the glochidium valves in the centers of the beaks. Young *Lampsilis* develop a byssus thread, about the thickness of a horse hair, and several inches long, fastened to a stone, or shell. The young mussel begins to develop its gonad in about the third year, and at that age has comparatively few ova and young in its marsupia. Only from that age on, young *Lampsilinae* begin to show sexual differences of the shells.

There is another physiological feature of interest. By examining thousands of specimens at various seasons of many years, it has been found that the mussels of the several groups are producing their young at different times. The *Unioninae*, also *Margaritana*, are found with their branchiae barren through autumn, winter and spring, but ova, and sperms developed in the gonads. In the summer, about June, the ova are transferred to the branchiae develop into glochidia within a week or two, and the young are discharged soon; the whole process taking about four weeks. In the *Lampsilinae*, and the *Anodontinae*, the marsupia become gravid in fall, in some as early as August; the transformation into glochidia here also takes only a week or two, and then the embryos, without any noticeable changes, are retained over winter and early spring, that is for eight to even ten months. The former were called short period or summer breeders, the latter long period or winter breeders.

To sum up: From these condensed and fragmentary outlines, it becomes evident that our Unionidae are not of the simple and uniform organization as was supposed, and that their study reveals many interesting features. For these reasons, they well deserve more attention than has been given them, as an object of study in the zoological laboratory, for their morphology, anatomy and physiology.

In conclusion, it may not be amiss to point out briefly the principle differences between the two groups of our fresh water Pelecypoda: the *Unionidae* of the Naiadacea, and the *Sphaeriidae* (*Sphaerium, Mucsulim, Pisidium* and *Eupera*) of the Cyrenacea. The latter,

of which we have about a hundred species, now known, in North America, and well worth being studied, are of much smaller size, the mussels being 1.5 to 20 mill. long when mature; their hinges are more complete; the mantle is less open and the siphons are closed, and tubes; the four branchiae are differently arranged; the young are developed in a special, brood pouch on the inside of the inner branchiae on each side; the young, when mature, are much larger than the glochidia of the Unionidae and fully developed.

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